ences, but it does not seem that it will make much progress thither so long as we are satisfied with "highs and lows" and supposed results which should mature from supposed absolute mathematical calculations. These latter are necessarily of the greatest possible value to the science, but it hardly seems that we shall arrive at a fundamental basis on these alone.

Hypotheses and theories whose nativity spring from deep mathematical calculation need much in the way of actual occurrence for their confirmation.

In meteorology we are dealing with a subject particularly profound and full of difficulties and easy snares. For example, consider the theories of cyclones and cyclone formation. Although these are considered to have been pretty well worked out, yet there seems to be no investigator who can state absolutely why cyclonic areas first appear on the western coast (mainly in the northwest), on the southern coast bounding the Gulf, or from the southeast. Neither can we find absolute facts which explain the varied paths of the western cyclones as they pass across our continent toward the Atlantic Ocean, nor have we any sure data for explaining their erratic rates of travel. All that seems to be attempted in this direction appears based on supposition and experience rather than on fixed and definite laws. The forecasters have certain rules on which to base their forecasts, but evidently these are not always justified by the facts. What, then, should be done to promote and maintain the dignity of meteorology as a science? Does it not seem that rigid research in other places than the Central Bureau is necessary?

It does seem that patient, qualified scientists, not necessarily civil servants by examination, devoted to the science, should be appointed in selected districts to make research into the meteorological phenomena and weather conditions for that specific locality, to record their results, and periodically make report of results as based on actual occurrences. These, passed on to the Central Bureau, could be further studied, and hypothetical reasoning would be proved or disproved by contact with the phenomena that have actually occurred as carefully observed over a period of time. Research, patient and faithful observation by independent men, as above outlined, would do very much in methods by which fundamental principles could be accurately established. Accident will never bring them, for the subject is too abstruse to admit of anything of the kind.

What ought to occur under certain conditions, and what does occur, are too often at variance, and it is for the maintenance of the conformity of these two conditions that devoted meteorologists should use all their energy and thought, together with true and faithful observation of actual facts.

THUNDERSTORMS AT TAMPA, FLA.
By JOSEPH BILY, JR., Assistant Observer.

Thunderstorms at Tampa, may be divided into two classes; those of the summer, which occur from May to September and are of great frequency, and those of the cooler months, which are distributed from October to April and are of but occasional occurrence. Storms of the former class are in nearly all cases of local origin, due to the convectional overturning of ascending air currents, but the thunderstorms of the winter type present a different character, and accompany cyclonic areas which drift eastward from Texas or the west Gulf of Mexico, and whose centers pass from 200 to 500 miles to the northwestward of Tampa.

During the summer months cyclonic disturbances are of rare occurrence in this region, being confined to northern latitudes. The cyclones of the West Indies, after recurving from their westerly course in West Indian waters, generally pass northward so far to the east as to give Tampa fair weather; or, when continuing on their westward drift and crossing the Gulf of Mexico, their centers are such a distance to the south

and west of Tampa that only occasional showers are experienced. When the centers of these storms pass in proximity to Tampa heavy rains and high winds result. Thus we see that but for the frequent occurrence of local thunderstorms in the summer the sources of rain are limited. The geographical form and location of central and southern Florida, a peninsula surrounded by large bodies of water, admit of this pronounced summer type of climate. There is thus a daily interchange of air between land and sea, except when interrupted by movements of vast eddies in the atmosphere, known as areas of high and low pressure.

The summer thunderstorms are noticeably mild when compared with those of a continental climate. The thunder is not loud, but a copious rainfall is a characteristic that may always be observed. These conditions seem to be the reverse of those in the interior and northern portions of the United States, where but little rain accompanies a mild thunderstorm, the heavy or copious rainfall being a marked feature of the severe thunderstorms of those regions.

During the warm season of the year when weather conditions are dominated by a permanent area of high pressure off the south Atlantic coast, the prevailing winds over west-central Florida are from south to east. The nights, as a rule, are clear after 10 p. m., but with the rising of the sun in the morning the lower stratum of air becomes rapidly heated, causing ascending currents, and by 7 a. m. cumulus "rolls" are seen springing into life on the horizon. These white "ball-like" clouds increase in number and size during the forenoon, and become in the early afternoon closely packed masses, from the edges of which protrude miniature mountain peaks or overgrown cumulus clouds with evident augmentation or "bubbling over" at the summit. Up to the time of maximum cloudiness the atmosphere is sultry and oppressive, but with the breaking of the storm and the downpour of rain, attended by a gust of wind, the temperature falls several degrees, which, with the decrease in humidity, produces an interval of relief. After the storm the clouds break away to some extent; the sun comes out, evaporating the fallen rain; the temperature tends to rise to its normal, and again the atmosphere is as sultry and oppressive as before the storm. The sky continues partly cloudy till evening, when the clouds decrease and disappear in the early night, while the air becomes cool and comparatively refreshing.

These storms have their greatest frequency in the afternoon, but occur in the forenoon as well as early night. Their prevailing movement is from the eastern quadrant, with a secondary frequency from the southern quadrant. They have, however, been noticed to move from all points of the compass, and at times the storm appears to be stationary. Nor are they of great diameter. There have been several occurrences of heavy rain accompanying these "locals" over the southern section of the city while in the northern portion only a trace or no rain fell; and a reverse of these conditions has also been known, all depending on the location and direction of movement of the center of the storm. As many as four distinct and separate thunderstorms have been noticed at the same time.

During the past fourteen years, 1890–1903, there have been six days with three thunderstorms occurring at various portions of the same day, and forty-two days with two such occurrences, distributed as follows:

Thunderstorms.	May.	June.	July.	August.	September.
Three in one day	0	4	1	1	0
Two in one day	4	11	17	10	0

The damage caused by the storms of the summer type is light,

as compared with the damage by lightning in higher latitudes. The preference of the lightning is for telegraph poles, trolley wires, and trees, the houses destroyed being few.

With the approach of the cooler months there is an increase in the number and movement of areas of high and low pressure, and a tendency to move across the southern portion of the United States. It is to this class of low-pressure areas that move eastward from the west Gulf of Mexico that thunderstorms of the winter type owe their existence. Thunderstorms do not always occur in connection with these areas of low pressure, the exceptions being when they move north of northeast by way of the lower Mississippi Valley, or when the temperature is low, and when there has been considerable cloudiness preceding the rain area.

The thunderstorms of the winter type invariably move over Tampa and the vicinity from west to east, or southwest to northeast. Prior to the breaking of the storm the wind blows steadily from the southeast for some time, having shifted to that position from a southerly point, the atmosphere is very oppressive, the temperature is high, the sky, which had been partly covered with clouds of cirrus formation, becomes overcast with a dark stratus layer, while huge cumulo-nimbus clouds appear on the western horizon. After the clouding of the sky the southeast wind lightens, and for a short while there is almost a lull, which is followed by a strong gust from the northwest, and the storm breaks in earnest. The downpour of rain begins almost instantly with the change of wind, but is not quite so heavy as that which accompanies the "locals" of the summer type. These storms are more severe than those of the summer type, although of about the same average duration; the thunder is louder, the lightning more vivid, while the wind, which shifts to the northwest at the commencement of the storm, continues brisk for about an hour or so. Generally they are followed by cooler weather lasting a day or two, accompanying an area of high pressure which moves southeastward to the Gulf States in the rear of the cyclonic disturbances.

The occurrence of these storms is not confined to any portion of the day, but the greatest frequency is in the middle afternoon. Of this type of thunderstorms during the fourteen years, 1890–1903, there have been but four days with two such occurrences to their credit, distributed as follows:

Thunderstorms.	October.	November.	December.	January.	February.	March.	April.
Two in one day	0	0	0	1	0	2	1

The transition period from the winter to the summer type occurs during the month of April, when low-pressure areas from the west Gulf of Mexico become rare and the diurnal changes of weather assume their ascendancy. The south Atlantic area of high pressure now becomes the influencing factor.

To enable the ready recognition of thunderstorms as belonging to either of the two types, summer or winter, during the transition periods in the spring and autumn, a brief synopsis of the principal features of each type is given as follows:

SUMMER TYPE.   WINTER TYPE.

BAROMETER.

Falls at a steady rate before storm, rises at outbreak of storm, and resumes its regular diurnal course after the passing of the storm.

Is low and falls up to the time of breaking of storm; then rises rapidly and continues to rise until the crest of the high-pressure area passes to the eastward.

TEMPERATURE.

High before the storm; falls during storm, but rises afterwards and assumes its normal for rest of the day.

The maximum for the day occurs just before the storm; the temperature falls during the storm and is low afterwards.

HUMIDITY.

Highest at outbreak of the storm; decreases during the storm, but increases to some extent after the storm.

Highest at outbreak of the storm; decreases during the storm and is low after the storm.

PRECIPITATION.

Rain falls in heavy showers, though generally there is a steady downpour; the ending is abrupt.

Rain falls heavily during first half hour or hour of a thunderstorm, then becomes light, and usually ends before last thunder.

WIND.

Easterly before the storm; shifts to fresh or brisk southwest or west at breaking of storm, decreasing in force shortly afterwards.

Steady southeast before the storm; shifts to brisk northwest at outbreak of storm; is fresh toward end of and after the storm.

TABLE 1.—*Number of days with thunderstorms at Tampa.*

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.	Departure from the normal.
1890				0	0	6	6	5	4	1	0	0	20	—36
1891	0	0	4	0	2	2	11	1	0	0	0	0	41	—15
1892	0	0	0	0	7	1	10	16	7	0	0	0	41	—15
1893	2	3	4	4	6	18	14	5	4	1	2	1	64	+ 8
1894	1	1	2	2	8	13	7	6	5	0	0	1	46	—10
1895	1	0	2	4	6	5	9	17	3	0	0	0	46	—10
1896	2	1	2	2	3	7	11	13	4	0	0	0	45	—11
1897	0	1	1	5	1	11	10	12	4	1	0	0	46	—10
1898	0	2	0	0	1	13	8	16	5	1	0	1	47	— 9
1899	2	4	1	3	3	17	11	12	12	2	0	0	67	+11
1900	1	2	3	5	5	15	22	22	5	3	1	1	85	+29
1901	1	2	4	3	6	15	20	24	3	1	0	0	79	+23
1902	0	3	3	2	9	6	13	15	13	3	0	1	68	+12
1903	4	1	8	3	7	15	26	22	8	0	2	1	97	+41
1904	3	3	9											
Average	1	2	3	3	4	10	12	14	6	1	0.4	0.4	*56	
Greatest	4	4	9	5	9	18	26	24	13	3	2	1	97	—36
Least	0	0	0	0	0	1	2	5	1	0	0	0	20	+ 8

*Average for the entire period.

Table 1, containing the monthly and annual number of days with thunderstorms for fourteen years, April, 1890, to March, 1904, shows that the average annual number of such days is fifty-six. In 1891 there was an average of one day with a thunderstorm in every eighteen days, while in 1903 the average was one such day in every four days; the average for the fourteen years is an occurrence of one day with a thunderstorm in every seven days, or one each week.

Table 2 gives the number of thunderstorms for each month and year for fourteen years from April, 1890, to March, 1904. Here we have an average of 60 thunderstorms for the year, or one to every six days, while the average annual number of days with thunderstorms is fifty-six, making a general average of fifteen thunderstorms to every fourteen days with thunderstorms, or an occurrence of two thunderstorms on one day of every fourteen thunderstorm days. The greatest annual number was 122 in 1903, an average of one thunderstorm to every three days; the least was twenty in 1891, an average of one thunderstorm to every eighteen days. The greatest monthly average is fifteen for August; the least is 0.4 for November and December. The greatest number of thunderstorms in any month was 38 in July, 1903, these occurring in twenty-six days.

TABLE 2.—*Number of thunderstorms at Tampa.*

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.	Departure from the normal.
1890	....	....	....	0	0	6	6	5	4	1	0	0	....	....
1891	0	0	0	4	0	2	2	11	1	0	0	0	20	−40
1892	0	0	0	0	7	1	10	16	7	0	0	0	41	−19
1893	2	3	4	4	6	22	15	5	4	1	2	1	69	+ 9
1894	1	1	2	2	8	13	8	6	5	0	0	1	47	−13
1895	1	0	2	4	5	4	11	20	4	0	0	0	50	−10
1896	2	1	2	2	3	7	11	13	4	0	0	0	45	−15
1897	0	1	1	4	1	11	10	14	4	1	0	0	47	−13
1898	0	2	0	0	1	14	8	15	5	1	0	1	47	−13
1899	2	4	1	3	3	19	12	13	11	2	0	0	70	+10
1900	1	2	3	6	5	16	23	22	5	3	1	1	88	+28
1901	1	2	4	2	7	15	20	25	3	1	0	0	80	+20
1902	0	3	3	2	9	6	14	19	13	3	0	1	73	+13
1903	4	1	8	3	9	25	38	23	8	0	2	1	122	+62
1904	4	3	10	....	....	....	....	....	....	....	....	....	....	....
Average	1	2	3	3	5	12	13	15	6	1	0.4	0.4	*60	....
Greatest	4	4	10	6	9	25	38	25	13	3	2	1	122	+62
Least	0	0	0	0	0	1	2	5	1	0	0	0	20	+ 9

*Average for the entire period.

The maximum period of successive days with thunderstorms, for each month and year, from April, 1890, to March, 1904, is given in Table 3. The longest period is seventeen days in 1903, from June 29 to July 15, inclusive; the shortest maximum period of any one year, three days, occurred in 1897.

The longest maximum period of any one month was fifteen days in July, 1903, from the 1st to the 15th, inclusive.

TABLE 3.—*Greatest number of consecutive days with thunderstorms at Tampa.*

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
1890	....	....	....	0	0	3	2	2	1	1	0	0	....
1891	0	0	0	4	0	2	1	4	1	0	0	0	4
1892	0	0	0	0	3	1	7	4	4	0	0	0	8
1893	2	2	1	2	3	9	6	3	2	1	1	1	9
1894	1	1	1	1	2	7	1	2	1	0	0	1	8
1895	1	0	1	1	2	2	3	6	1	0	0	0	6
1896	2	1	1	2	2	2	3	5	1	0	0	0	5
1897	0	1	1	2	1	3	3	3	1	1	0	0	3
1898	0	2	0	0	1	4	2	5	2	1	0	1	5
1899	1	2	1	1	1	6	3	3	5	1	0	0	6
1900	1	1	1	4	2	6	8	9	2	2	1	1	9
1901	1	1	1	2	3	4	7	8	1	1	0	0	8
1902	0	1	2	1	3	2	3	4	7	1	0	1	7
1903	1	1	5	1	2	6	15	10	2	0	1	1	17
1904	1	2	3	....	....	....	....	....	....	....	....	....	....
Greatest	2	2	5	4	3	9	15	10	5	2	1	1	17

TABLE 4.—*Average duration of thunderstorms (hours and minutes).*

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
1890	....	....	....	0	0	2 34	3 31	3 05	2 43	4 00	....	0	3 20
1891	0	0	0	3 45	0	2 10	1 28	1 38	1 17	0	0	0	1 58
1892	0	0	0	0	1 10	0 42	1 26	1 58	1 26	0	0	0	1 29
1893	1 50	1 00	3 30	1 23	2 07	1 43	0 57	1 22	1 56	....	0 45	4 27	2 04
1894	0 49	0 30	0 55	1 48	1 46	2 12	3 00	2 04	2 35	0	0	1 03	1 58
1895	....	0	4 26	3 18	2 41	2 18	2 12	1 35	1 48	0	0	0	3 03
1896	2 52	1 35	1 44	0 34	1 04	2 57	1 32	1 50	1 41	0	0	0	1 47
1897	0	3 45	1 35	2 55	2 05	1 44	2 26	1 26	1 06	3 25	0	0	2 19
1898	0	1 10	0	0	0 40	2 01	2 26	2 13	1 45	1 25	0	....	1 42
1899	0 48	1 20	0 30	2 13	1 18	2 05	1 36	1 41	2 08	0 41	0	0	1 28
1900	3 08	1 25	5 25	1 36	1 32	1 53	2 11	2 42	0 40	1 38	0 25	1 27	2 08
1901	0 05	1 55	1 51	3 49	1 30	1 48	2 13	1 29	1 13	0 20	0	4	1 40
1902	0	3 15	1 28	0 58	2 10	2 28	3 14	1 22	2 32	1 17	0	4 00	2 16
1903	0 36	0 05	1 30	1 15	1 04	1 36	1 19	1 50	1 00	0	1 39	0 10	1 13
1904	1 19	0 52	1 26	....	....	....	....	....	....	....	....	....	....
Av'rage	1 20	1 33	1 56	2 28	1 38	1 57	1 58	1 50	1 48	1 36	1 03	2 13	1 54
Gr'test	3 08	3 45	5 25	3 49	2 41	2 57	3 31	3 05	2 43	4 00	1 39	4 27	3 20
Least	0 05	0 05	0 30	0 34	0 40	0 42	0 57	1 22	0 40	0 20	0 25	0 10	1 13

Table 4 gives the mean duration of thunderstorms for each month and year from April, 1890, to March, 1904. At the foot of the table are given the average duration, for each month and for the year, during fourteen years, and also the greatest and least mean monthly and mean annual durations. The

time of duration considered in this table is the interval between the first and last thunder of a thunderstorm. The average duration of all thunderstorms for the entire period is 1h 54m. The greatest monthly average duration is 2h 28m in April the least is 1h 03m in November. The greatest mean duration of any one month was 5h 25m in March, 1900; the least was 0h 5m in January, 1901, and February, 1903. The longest duration of any thunderstorm was 10h 57m on June 10, 1900; the shortest duration was only one peal on several occasions. The period of time during which thunder has been heard at Tampa from 1890 to 1903 is as follows:

Year.	Duration.	Year.	Duration.	Year.	Duration.
	Hrs. mins.		*Hrs. mins.*		*Hrs. mins.*
1890	70 02	1895	130 50	1900	181 52
1891	41 20	1896	78 45	1901	120 00
1892	54 40	1897	106 32	1902	165 28
1893	132 15	1898	78 20	1903	146 24
1894	78 20	1899	99 10		

TABLE 5.—*Daily frequency of thunderstorms at Tampa (April, 1890, to March, 1904).*

Day of month.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
1	0	0	3	1	2	6	8	5	5	0	1	0	....
2	0	0	2	1	2	5	5	5	5	1	0	0	....
3	0	0	0	0	2	5	7	5	4	1	0	0	....
4	0	1	1	0	2	2	4	7	8	2	1	2	....
5	0	1	0	0	1	6	5	8	5	0	0	0	....
6	0	0	1	1	3	4	6	9	3	0	1	0	....
7	0	0	1	1	1	5	6	8	6	0	0	0	....
8	0	0	1	0	2	6	7	6	5	0	0	0	....
9	0	0	1	2	5	7	5	6	2	1	0	0	....
10	2	0	1	0	1	7	6	9	1	1	0	0	....
11	0	0	1	1	2	4	6	6	3	1	0	1	....
12	1	3	1	1	2	2	4	5	3	0	0	0	....
13	0	2	1	1	2	5	6	10	4	0	0	0	....
14	0	0	2	2	1	2	5	4	4	2	0	0	....
15	0	1	1	2	1	3	5	5	1	0	0	0	....
16	0	0	1	1	4	2	7	7	4	0	0	1	....
17	2	0	1	2	1	4	6	6	2	1	0	0	....
18	0	2	0	2	0	4	5	6	3	1	0	0	....
19	0	3	3	3	1	4	6	3	2	0	0	0	....
20	0	1	5	2	4	3	7	7	2	0	0	0	....
21	1	1	2	1	2	4	9	7	1	1	0	0	....
22	1	1	2	1	2	3	5	3	6	0	0	0	....
23	3	1	1	0	1	7	2	5	0	1	1	2	....
24	0	1	0	1	3	5	3	6	0	0	0	0	....
25	0	1	2	2	2	4	6	4	1	0	0	0	....
26	1	1	4	3	2	5	6	6	1	0	0	0	....
27	0	0	1	1	2	6	4	7	2	0	1	0	....
28	2	3	0	2	0	6	5	7	1	0	0	0	....
29	2	....	0	2	1	8	5	6	0	0	0	0	....
30	1	....	0	1	2	8	6	8	0	0	0	0	....
31	1	....	0	....	3	....	5	7	....	0	....	0	....
Sums	17	23	39	37	60	144	169	196	78	13	5	6	787
Average	1	2	3	3	4	10	12	14	6	1	0.4	0.4	56
Percentage	2	3	5	5	8	18	21	25	10	2	0.6	0.8	100

Table 5, showing the daily frequency of thunderstorms, gives the number of thunderstorm days for each day of the year during a period of fourteen years. The total number of days with thunderstorms during the fourteen years was 787. Of this number August has a frequency of 196 days, or 25 per cent of the total number of days with thunderstorms. The least frequency is in November, the percentage of the annual number being but 0.6. August 13 has the greatest frequency of any day in the year, thunderstorms having occurred on ten such days out of a possible fourteen, a frequency of 71 per cent.

Tables 6 and 7 present the hourly occurrences of thunderstorms and are based on the time of beginning, without regard to the duration of the storm. Table 6 exhibits the distribution of thunderstorms during each hour of the day, local time, or hourly frequency, while Table 7 gives the percentage of hourly occurrences of thunderstorms for the month and year. The greatest hourly frequency of occurrences for the fourteen years is between 3 p. m. and 4 p. m. during which hour 98 thunderstorms had their beginning; the hours 12

noon to 1 p. m. and 2 p. m. to 3 p. m. are next with a frequency of 95, and the hour 1 p. m. to 2 p. m. follows with a frequency of 93. Thus we see that the greatest frequency of thunderstorms is during the early afternoon hours. The least likelihood, or frequency, of occurrence of thunderstorms is during the hour 11 p. m. to 12 midnight, only one such occurrence being recorded during the fourteen years, and that taking place on June 21, 1897.

TABLE 6.—*Hourly frequency of thunderstorms at Tampa (April, 1890, to March, 1904), local time.*

Hour.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Sums.
12 mid. to 1 a. m.		1	1										2
1 a. m. to 2 a. m.	1		1	2					1		1		6
2 a. m. to 3 a. m.									1		1		2
3 a. m. to 4 a. m.		2							1		1		4
4 a. m. to 5 a. m.	1	1	2		2	1		1					8
5 a. m. to 6 a. m.		1	1	2			3	1					8
6 a. m. to 7 a. m.	1		1	1	1		1	2	2				9
7 a. m. to 8 a. m.		1		1	1	3	3	4	1				14
8 a. m. to 9 a. m.	1		2	2	3	2	2	6	3		1		22
9 a. m. to 10 a. m.			1	1	1	1	4	3	1			1	13
10 a. m. to 11 a. m.			1	1	2	8	9	12	1		1	1	36
11 a. m. to 12 noon	2	2	3	2	2	8	13	18	2	1			53
12 noon to 1 p. m.			3	3	6	15	24	31	10	1	1	1	95
1 p. m. to 2 p. m.	1	1	2	2	8	15	30	19	13	1	1		93
2 p. m. to 3 p. m.	2	3	3	3	6	13	24	22	17	2			95
3 p. m. to 4 p. m.	2	2	3	5	4	25	24	25	5	3			98
4 p. m. to 5 p. m.	1	3	2	3	8	15	19	16	9			2	78
5 p. m. to 6 p. m.		2	3		5	12	8	13	4		1		48
6 p. m. to 7 p. m.	3	1	4	4	3	14	5	14	4	1			53
7 p. m. to 8 p. m.	1			1	6	8	2	3	2				23
8 p. m. to 9 p. m.	1		2	2	1	4	4	5	2				21
9 p. m. to 10 p. m.		2				4		3					9
10 p. m. to 11 p. m.		1	1		1	1	1			1			6
11 p. m. to 12 mid.						1							1
Sums	17	23	36	35	60	150	176	201	77	12	5	5	*797
Greatest hourly frequency	3	3	4	5	8	25	30	31	17	3	1	2	98
Hour of greatest frequency, p.m.	6-7	2-3 / 4-5	6-7	3-4	1-2 / 4-5	3-4	1-2	†12 -1	2-3	3-4	†12 -2	4-5	3-4

*Excluding 41 thunderstorms indeterminable as to time. † Noon.

TABLE 7.—*Hourly percentage of thunderstorms (April, 1890, to March, 1904), local time.*

Hour.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
12 mid. to 1 a. m.		4	3										0.3
1 a. m. to 2 a. m.	6		3	6				0.5		8			0.8
2 a. m. to 3 a. m.								0.5		8			0.3
3 a. m. to 4 a. m.		9						0.5		8			0.5
4 a. m. to 5 a. m.	6	4	6		3	1		0.5					1.0
5 a. m. to 6 a. m.		4	3	6			2	0.5					1.0
6 a. m. to 7 a. m.	6		3	3	2		1	1.0	3				1.0
7 a. m. to 8 a. m.		4		3	2	2	2	2.0	1				2.0
8 a. m. to 9 a. m.	6		6	6	5	1	1	3.0	4		20		3.0
9 a. m. to 10 a. m.			3	3	2	1	2	1.0	1			20	2.0
10 a. m. to 11 a. m.			3	3	3	5	5	6.0	1		20	20	5.0
11 a. m. to 12 noon	12	9	8	6	3	5	7	9.0	3	8			7.0
12 noon to 1 p. m.			8	9	10	10	14	15.0	13	8	20	20	12.0
1 p. m. to 2 p. m.	6	4	6	6	13	10	17	9.0	17	8	20		12.0
2 p. m. to 3 p. m.	12	13	8	9	10	9	14	11.0	22	17			12.0
3 p. m. to 4 p. m.	12	9	8	14	7	17	14	12.0	6	25			12.0
4 p. m. to 5 p. m.	6	13	6	9	13	10	11	8.0	12			40	10.0
5 p. m. to 6 p. m.		9	8		8	8	5	6.0	5		20		6.0
6 p. m. to 7 p. m.	18	4	11	11	5	9	3	7.0	5	8			7.0
7 p. m. to 8 p. m.	6			3	10	5	1	1.0	3				3.0
8 p. m. to 9 p. m.	6		6	6	2	3	2	2.0	3				3.0
9 p. m. to 10 p. m.		9				3		1.0					1.0
10 p. m. to 11 p. m.		2	3		2	1	1		1				0.8
11 p. m. to 12 mid.						1							0.1
Greatest hourly percentage	18	13	11	14	13	17	17	15.0	22	25	20	40	12.0

The greatest hourly percentage of occurrence for the year is twelve, and is for each of the hours from 12 noon to 4 p. m.; the least is 0.1 for the hour 11 p. m. to midnight. The hour of greatest percentage of occurrences varies for the months, but is confined to the afternoon, the range lying between 12 noon and 7 p. m. From January to March the hour of greatest percentage of occurrences is in the evening. It then moves toward the middle of the day with approach of the summer months, the hour being 12 noon to 1 p. m. in August, when it

recedes to the late afternoon as winter comes on. The hours of greatest frequency of occurrence are given at the base of Table 6.

TABLE 8.—*Monthly and annual precipitation, inches and hundredths.*

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
1890				0.55	4.49	11.58	11.91	8.87	9.24	5.05	3.31	1.32	
1891	1.95	0.98	3.24	2.77	0.69	7.12	4.52	9.48	7.96	2.61	1.99	1.15	44.46
1892	3.25	1.13	1.58	0.31	3.03	12.41	3.94	8.60	6.67	1.34	1.28	3.12	46.66
1893	2.36	1.71	6.57	1.34	2.67	10.89	2.11	8.56	6.24	2.46	2.73	1.32	48.96
1894	1.42	2.73	1.71	1.36	6.92	9.15	11.56	7.16	17.28	4.84	2.26	0.54	66.93
1895	3.40	3.99	2.07	5.38	1.29	4.24	10.63	8.88	4.80	3.04	1.78	1.14	50.64
1896	3.38	3.77	2.16	0.86	2.27	13.42	12.30	7.96	7.30	1.00	1.25	2.87	59.63
1897	1.42	5.40	1.44	4.65	0.33	8.46	6.23	7.84	10.73	4.78	0.63	2.50	54.41
1898	0.42	1.52	0.08	0.16	0.37	5.96	8.29	17.83	6.57	4.50	1.96	2.87	50.53
1899	6.45	6.27	1.40	3.39	0.48	12.18	15.53	4.93	8.35	2.42	0.24	2.18	63.82
1900	4.86	4.15	7.36	3.74	2.33	7.88	4.40	6.90	4.86	5.11	0.96	3.40	55.45
1901	1.15	1.76	3.58	1.63	4.31	7.52	6.82	8.03	5.18	0.36	0.48	1.24	42.06
1902	0.28	5.72	1.91	1.07	4.11	6.43	7.64	7.35	10.14	3.37	0.97	1.39	50.38
1903	6.33	6.06	4.79	0.74	1.92	5.38	9.34	6.00	10.64	0.93	3.09	1.46	56.68
1904	6.73	3.20	0.77										
Av'ge.	3.06	3.46	2.76	2.00	2.52	8.76	8.23	8.46	8.28	2.99	1.83	1.78	*54.12
Gr'test	6.73	6.27	7.36	5.38	6.92	13.42	15.53	17.83	17.28	5.11	3.96	3.40	66.93
Least	0.28	0.98	0.08	0.16	0.33	4.24	2.11	4.93	4.80	0.36	0.24	0.54	42.06

*Average for the entire period.

It must be admitted that thunderstorms and precipitation bear a close relation to one another, since it is seldom that a thunderstorm will occur without a copious fall of rain, or at least a trace over some portion of the region traversed by the storm. The effect of thunderstorms upon the rainfall distribution for the year at Tampa is well marked during the summer months, from the last decade in May to the first decade in October, inclusive; this period is termed the rainy season. With the increase in number of thunderstorms the monthly average rainfall advances from 2.52 inches in May to 8.76 inches in June, and remains above 8.00 inches throughout the following three months, when it decreases to 2.99 inches in October. The least monthly average is 1.78 inches in December. The rainfall increases during the months of January and February, when cyclonic areas from the west are at their maximum frequency, and then decreases to its secondary minimum monthly average of 2.00 inches in April. Table 8 gives the monthly and annual precipitation during the fourteen years, April, 1890–March, 1904, and the average for the month and
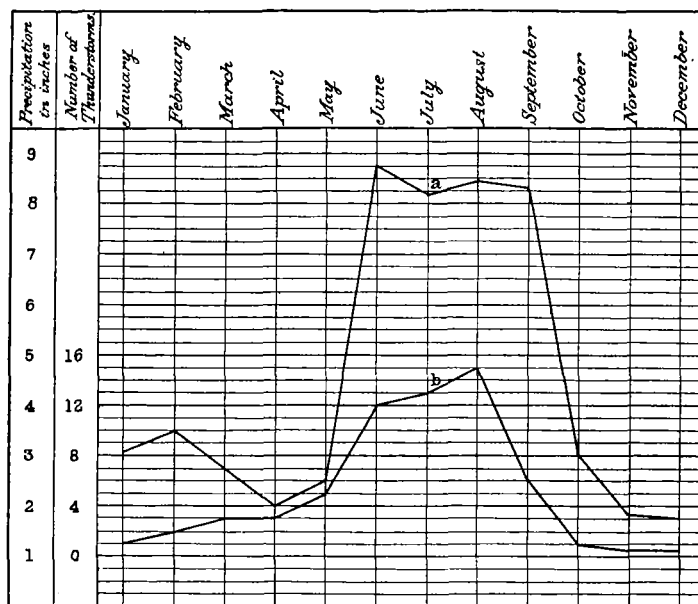

FIG. 1.—Average monthly precipitation and number of thunderstorms for fourteen years, April, 1890–March, 1904. a. Average monthly rainfall. b. Average monthly number of thunderstorms.

year. Fig. 1 shows the relation between the average monthly rainfall and the average monthly number of thunderstorms.[1]

AN INDEX OF METEOROLOGICAL ITEMS IN THE JESUIT RELATIONS.

By Rev. F. L. ODENBACH, S. J.

("The Jesuit Relations and Allied Documents," Burrows Brothers, Cleveland, Ohio, is a reprint, in about 73 volumes, of the accounts by the French Jesuit missionaries of their travels and explorations in Canada and the Northern and Northwestern States of the United States, from 1610 to 1791. The reprint includes both the original narrations and an English translation thereof. From the exhaustive general index Father Odenbach has culled all entries relating to the weather or meteorological phenomena.—*F. O. S.*)

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RECENT PAPERS BEARING ON METEOROLOGY.

Mr. H. H. KIMBALL, Librarian and Climatologist.

The subjoined titles have been selected from the contents of the periodicals and serials recently received in the Library of the Weather Bureau. The titles selected are of papers or other communications bearing on meteorology or cognate branches of science. This is not a complete index of the meteorological contents of all the journals from which it has been compiled; it shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau. Unsigned articles are indicated by a ——.

Nature. London. Vol. 71.
    Sutton, J. R. Sir J. Eliot's Address at Cambridge. [Precipitation in South Africa.] Pp. 6–7.
    —— Floods in the Mississippi. [Abstract of work of H. C. Frankenfield.] Pp. 10–11.
Quarterly Journal of the Royal Meteorological Society. London. Vol. 30.
    Dallas, W. L. The variation of the population of India compared with the variation of rainfall in the decennium 1891–1901. Pp. 273–285.
    Knight, Arthur. Dry haze at Singapore. [Note.] Pp. 285–286.
    Russell, F. A. R. The principal causes of rain. Pp. 287–290.

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[1] Such graphical representations have obvious advantages, but they are likely to be misleading to the student unless he is careful to find out in each case just how much the diagram includes and what it omits. The present diagram, for example, is based on monthly averages. We can not select a point midway between two months and say that this represents conditions on the 15th of the month, or on any other definite dates The only points on these curves that have any significance are those that fall on the vertical lines. The intervening portions of the curve serve to guide the eye, and to indicate the correspondence between the change. in the two elements considered.—*F. O. S.*